

1. A method of forming a light emitting device comprising depositing a first phosphor material over a semiconductor light emitter and depositing a second phosphor material over said first phosphor material, wherein said first phosphor material has at least one of a shorter decay time and a lower absorption of radiation from said semiconductor light emitter than said second phosphor material.

2. A method according to claim 1, wherein said semiconductor light emitter comprises a light emitting diode.

3. A method according to claim 2, wherein said light emitting diode emits in the wavelength of from about 350 to 440 nm.

4. A method according to claim 1, wherein said first phosphor material is disposed in a matrix material and applied to the LED as a layer.

5. A method according to claim 4, wherein said matrix material is selected from silicone, epoxy and mixtures thereof.

6. A method according to claim 1, further comprising one or more additional phosphor materials.

7. A method according to claim 1, wherein said first phosphor material has at least one of a luminescence decay time of less than about 3 ms and a plaque absorption of less than about 60% at a mean particle size of 10 μm .

8. A method according to claim 1, wherein said second phosphor material has at least one of a luminescence decay time of greater than about 10 ms and a plaque absorption of greater than about 80% at a mean particle size of 10 μm .

9. A method according to claim 1, wherein said first phosphor material comprises $\text{Eu}^{2+}\text{-Mn}^{2+}$ phosphors.

10. A method according to claim 1, wherein said first phosphor material comprises $(\text{Sr,Ca,Ba,Mg,Zn})_2\text{P}_2\text{O}_7\text{:Eu}^{2+}, \text{Mn}^{2+}$; $\text{Sr}_4\text{Al}_{14}\text{O}_{25}\text{:Eu}^{2+}$; or blends thereof.

11. A method according to claim 1, wherein said second phosphor material comprises $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$.

12. A method according to claim 1, wherein said first phosphor material comprises one or more of $(\text{Ba}, \text{Sr}, \text{Ca})\text{Al}_2\text{O}_4:\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})_2\text{SiO}_4:\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})_2(\text{Mg}, \text{Zn})\text{Si}_2\text{O}_7:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba})(\text{Al}, \text{Ga}, \text{In})_2\text{S}_4:\text{Eu}^{2+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{Cl}_2:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca})_{10}(\text{PO}_4)_6 \cdot n\text{B}_2\text{O}_3:\text{Eu}^{2+}$; $2\text{SrO} \cdot 0.84\text{P}_2\text{O}_5 \cdot 0.16\text{B}_2\text{O}_3:\text{Eu}^{2+}$; $\text{Sr}_2\text{Si}_3\text{O}_8 \cdot 2\text{SrCl}_2:\text{Eu}^{2+}$; $\text{Ba}_3\text{MgSi}_2\text{O}_8:\text{Eu}^{2+}$; $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$; $\text{BaAl}_8\text{O}_{13}:\text{Eu}^{2+}$; $(\text{Y}, \text{Gd}, \text{Tb}, \text{La}, \text{Sm}, \text{Pr}, \text{Lu})_3(\text{Al}, \text{Ga})_5\text{O}_{12}:\text{Ce}^{3+}$; and blends thereof.

13. A method according to claim 1, wherein said second phosphor material comprises one or more of $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba}, \text{Mg}, \text{Zn})_2\text{P}_2\text{O}_7:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{C}_{12}:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgP}_2\text{O}_7:\text{Eu}^{2+}, \text{Mn}^{2+}$; $3.5\text{MgO} \cdot 0.5\text{MgF}_2 \cdot \text{GeO}_2:\text{Mn}^{4+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{C}_{12}:\text{Eu}^{2+}, \text{Mn}^{2+}$; and blends thereof.

14. A light emitting device comprising a semiconductor light emitter and at least two phosphor materials, wherein a first phosphor material is disposed closer to said light emitting diode or laser diode than a second phosphor material, said first phosphor material having at least one of a shorter decay time and a lower absorption of radiation emitted from said semiconductor light emitter than said second phosphor material.

15. A device according to claim 14, wherein said light emitter comprises a light emitting diode or a laser diode.

16. A device according to claim 14, wherein said light emitting diode or laser diode emits between about 350 and 440 nm.

17. A device according to claim 14, wherein said first phosphor material is disposed in a matrix material and applied to the LED as a layer.

18. A device according to claim 17, wherein said matrix material is selected from silicone, epoxy and mixtures thereof.

19. A device according to claim 14, further comprising one or more additional phosphor materials.

20. A device according to claim 14, wherein said first phosphor material has at least one of a luminescence decay time of less than about 3 ms and a plaque absorption of less than about 60% at a mean particle size of 10 μm .

21. A device according to claim 14, wherein said second phosphor material has at least one of a luminescence decay time of greater than about 10 ms and a plaque absorption of greater than about 80% at a mean particle size of 10 μm .

22. A device according to claim 14, wherein said first phosphor material comprises Eu^{2+} - Mn^{2+} phosphors.

23. A device according to claim 14, wherein said first phosphor material comprises $(\text{Sr}, \text{Ca}, \text{Ba}, \text{Mg}, \text{Zn})_2\text{P}_2\text{O}_7:\text{Eu}^{2+}, \text{Mn}^{2+}$; $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$; or blends thereof.

24. A device according to claim 14, wherein said second phosphor material comprises $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$.

25. A device according to claim 14, wherein said first phosphor material comprises one or more of $(\text{Ba}, \text{Sr}, \text{Ca})\text{Al}_2\text{O}_4:\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})_2\text{SiO}_4:\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})_2(\text{Mg}, \text{Zn})\text{Si}_2\text{O}_7:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba})(\text{Al}, \text{Ga}, \text{In})_2\text{S}_4:\text{Eu}^{2+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{Cl}_2:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$; $(\text{Sr}, \text{Ca})_{10}(\text{PO}_4)_6 * n\text{B}_2\text{O}_3:\text{Eu}^{2+}$; $2\text{SrO} * 0.84\text{P}_2\text{O}_5 * 0.16\text{B}_2\text{O}_3:\text{Eu}^{2+}$; $\text{Sr}_2\text{Si}_3\text{O}_8 * 2\text{SrCl}_2:\text{Eu}^{2+}$; $\text{Ba}_3\text{MgSi}_2\text{O}_8:\text{Eu}^{2+}$; $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$; $\text{BaAl}_8\text{O}_{13}:\text{Eu}^{2+}$; $(\text{Y}, \text{Gd}, \text{Tb}, \text{La}, \text{Sm}, \text{Pr}, \text{Lu})_3(\text{Al}, \text{Ga})_5\text{O}_{12}:\text{Ce}^{3+}$; and blends thereof.

26. A device according to claim 14, wherein said second phosphor material comprises one or more of $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Sr}, \text{Ca}, \text{Ba}, \text{Mg}, \text{Zn})_2\text{P}_2\text{O}_7:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{C}_{12}:\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ba}, \text{Sr}, \text{Ca})\text{MgP}_2\text{O}_7:\text{Eu}^{2+}, \text{Mn}^{2+}$; $3.5\text{MgO} \cdot 0.5\text{MgF}_2 \cdot \text{GeO}_2:\text{Mn}^{4+}$; $(\text{Ca}, \text{Sr}, \text{Ba}, \text{Mg})_{10}(\text{PO}_4)_6(\text{F}, \text{Cl}, \text{Br}, \text{OH}):\text{Eu}^{2+}, \text{Mn}^{2+}$; $(\text{Ca}, \text{Sr})_8(\text{Mg}, \text{Zn})(\text{SiO}_4)_4\text{C}_{12}:\text{Eu}^{2+}, \text{Mn}^{2+}$; and blends thereof.

27. A device according to claim 14 having a color temperature between about 2,500 k and 10,000 k.

28. A device according to claim 14 having a CRI of at least 50.

29. A light emitting device comprising a light emitting diode or laser emitting diode and at least two phosphor materials, wherein a first phosphor material is positioned such that radiation emitted from said light emitting diode or laser emitting diode strikes said first phosphor material prior to striking said second phosphor material, and further wherein said first phosphor material has at least one of a shorter decay time and a lower absorption of radiation emitted from said light emitting diode or laser emitting diode than said second phosphor material.

30. A light emitting device according to claim 29, wherein said first phosphor material has a lower thermal quenching than said second phosphor material.

31. A method of forming a light emitting device comprising depositing a first phosphor material over a semiconductor light emitter and depositing a second phosphor material over said first phosphor material, wherein said first phosphor material has reduced thermal quenching than said second phosphor material.

32. A method according to claim 31, wherein said semiconductor light emitter comprises a light emitting diode.

33. A method according to claim 32, wherein said light emitting diode emits in the wavelength of from about 350 to 440 nm.

34. A method according to claim 31, wherein said first phosphor material is disposed in a matrix material and applied to the LED as a layer.

35. A method according to claim 34, wherein said matrix material is selected from silicone, epoxy and mixtures thereof.

36. A method according to claim 31, wherein said first and second phosphor materials comprise one or more of $(\text{Ba,Sr,Ca})\text{Al}_2\text{O}_4\text{:Eu}^{2+}$; $(\text{Ba,Sr,Ca})_2\text{SiO}_4\text{:Eu}^{2+}$; $(\text{Ba,Sr,Ca})_2(\text{Mg,Zn})\text{Si}_2\text{O}_7\text{:Eu}^{2+}$; $(\text{Sr,Ca,Ba})(\text{Al,Ga,In})_2\text{S}_4\text{:Eu}^{2+}$; $(\text{Ca,Sr,Ba,Mg})_{10}(\text{PO}_4)_6(\text{F,Cl,Br,OH})\text{:Eu}^{2+}$; $(\text{Ca,Sr})_8(\text{Mg,Zn})(\text{SiO}_4)_4\text{Cl}_2\text{:Eu}^{2+}$; $(\text{Sr,Ca,Ba,Mg})_{10}(\text{PO}_4)_6(\text{F,Cl,Br,OH})\text{:Eu}^{2+}$; $(\text{Ba,Sr,Ca})\text{MgAl}_{10}\text{O}_{17}\text{:Eu}^{2+}$; $(\text{Sr,Ca})_{10}(\text{PO}_4)_6\text{:Eu}^{2+}$; $2\text{SrO}\cdot 0.84\text{P}_2\text{O}_5\cdot 0.16\text{B}_2\text{O}_3\text{:Eu}^{2+}$; $\text{Sr}_2\text{Si}_3\text{O}_8\cdot 2\text{SrCl}_2\text{:Eu}^{2+}$; $\text{Ba}_3\text{MgSi}_2\text{O}_8\text{:Eu}^{2+}$; $\text{Sr}_4\text{Al}_{14}\text{O}_{25}\text{:Eu}^{2+}$; $\text{BaAl}_8\text{O}_{13}\text{:Eu}^{2+}$; $(\text{Y,Gd,Tb,La,Sm,Pr,Lu})_3(\text{Al,Ga})_5\text{O}_{12}\text{:Ce}^{3+}$; $(\text{Ba,Sr,Ca})\text{MgAl}_{10}\text{O}_{17}\text{:Eu}^{2+},\text{Mn}^{2+}$; $(\text{Sr,Ca,Ba,Mg,Zn})_2\text{P}_2\text{O}_7\text{:Eu}^{2+},\text{Mn}^{2+}$; $(\text{Ca,Sr,Ba,Mg})_{10}(\text{PO}_4)_6(\text{F,Cl,Br,OH})\text{:Eu}^{2+},\text{Mn}^{2+}$; $(\text{Ca,Sr})_8(\text{Mg,Zn})(\text{SiO}_4)_4\text{C}_{12}\text{:Eu}^{2+},\text{Mn}^{2+}$; $(\text{Ba,Sr,Ca})\text{MgP}_2\text{O}_7\text{:Eu}^{2+},\text{Mn}^{2+}$; $3.5\text{MgO}\cdot 0.5\text{MgF}_2\cdot \text{GeO}_2\text{:Mn}^{4+}$; $(\text{Ca,Sr,Ba,Mg})_{10}(\text{PO}_4)_6(\text{F,Cl,Br,OH})\text{:Eu}^{2+},\text{Mn}^{2+}$; $(\text{Ca,Sr})_8(\text{Mg,Zn})(\text{SiO}_4)_4\text{C}_{12}\text{:Eu}^{2+},\text{Mn}^{2+}$; and blends thereof.

37. A method according to claim 31, further wherein said first phosphor material has at least one of a shorter decay time and a lower absorption of radiation from said semiconductor light emitter than said second phosphor material.